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Sir:

Transmitted herewith for filing is the patent application of Inventor(s):

Brian J. Andonian

For: **Simulated Steering Feel System**

Enclosed are:

- ☒ 1 sheet(s) of drawings
- ☒ Executed Declaration
- ☒ Assignment and Cover Sheet
- ☒ Information Disclosure Statement, PTO Form 1449, and Copies of Citations
- ☐ A certified copy of

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# **SIMULATED STEERING FEEL SYSTEM**

## **Technical Field**

The present invention relates generally to a simulated steering feel system and more particularly to  
5 a simulated steering feel system utilizing a servo disk motor.

## **Background Of The Invention**

The use of simulated steering feel systems (SSFS) is well known in the prior art. SSFS's are  
10 presently used for a variety of applications including automotive drive simulators, engineering research tools, and entertainment devices. In addition, as advancements in automotive design continue to progress, advancements such as steer by wire (SBW) will likely  
15 require SSFS's in order to provide "road feel" or feedback response to a driver.

Although new improved uses of SSFS's will continue to develop, current SSFS can have undesirable characteristics. Current SSFS designs commonly use  
20 conventional brush or brushless electric motors. Such conventional electric motors can have disadvantages. Often conventional electric motors add undesirable weight to the SSFS's. Application work requirements can also lead to the need for undesirably large and  
25 heavy conventional motors. The high inertia of some conventional motors can also limit the acceleration capabilities of conventional motors and thereby limit the performance characteristics of the SSFS's in which

they are used. In addition, conventional motors can create torque ripple or "cogging" effects which are highly undesirable.

It would, therefore, be highly desirable to have a simulated steering feel system with reduced size and weight and that contains further improvements over present SSFS designs utilizing conventional brush or brushless motors.

### Summary of the Invention

It is therefore an object of the present invention to provide a simulated steering feel system that allows for reduced size, increased performance, and eliminates cogging.

In accordance with the objects of the present invention, a simulated steering feel system is provided. A simulated steering feel system includes a servo disk motor. The servo disk motor is utilized to allow feedback torque to a steering wheel. Using this servo disk motor, road feel can be imparted to the steering wheel from a small reduced weight package with improved performance.

Other objects and features of the present invention will become apparent when viewed in light of the detailed description of the preferred embodiment when taken in conjunction with the attached drawings and appended claims.

## Brief Description Of The Drawings

FIGURE 1 is an embodiment of a simulated steering feel system in accordance with the present invention for use in an automobile; and

FIGURE 2 is an embodiment of a simulated steering feel system in accordance with the present invention for use in a driving simulator.

## Description Of The Preferred Embodiment(s)

Referring now to Figure 1, which is an illustration of an embodiment of a simulated steering feel system 10 in accordance with the present invention. The embodiment illustrated in Figure 1 is preferably for use in an automobile to be used in conjunction with the steer by wire system, although the illustrated embodiment can be used in conjunction with any automotive system where simulated steer feel is desired. In an alternate embodiment, whose descriptions will follow, the simulated steering feel system 10 can be used in a variety of applications, including applications independent of an automobile.

The simulated steering feel system 10 includes a servo disk actuator 12. In its basic form, the servo disk actuator 12 includes at least one servo disk motor 14. Servo disk motors are well known in the electronic industry. Servo disk motors are also commonly referred to as disk motors, printed circuit board motors, or pancake motors. One advantage of using a servo disk motor, is that servo disk motors provide higher torque with a smaller package than

conventional electric motors. In addition, servo motors do not suffer from torque ripple or cogging effects commonly found in conventional electric motors. Servo disk motors also provide smoother torque with improved acceleration. Although the servo disk actuators 12 can include only a servo disk motor 14, alternate embodiments may include additional components.

In one embodiment, the servo disk actuator 12 can additionally include a torque multiplier 16. Torque multipliers are well known in the prior art. Torque multipliers 16 commonly consist of pulleys, belts, or gear reducers, although a variety of torque multipliers 16 are known. It is known that torque multipliers 16 can be combined with servo disk motors 14 to magnify the torque generated by the servo disk motor 14. It is known that torque multipliers 16 are available in a variety of reduction ratios. Common ranges of reduction ratios vary from 10:1 to 100:1, although additional reduction ratios are possible.

In still another embodiment, the servo disk actuator 12 can include a steering wheel sensor 18. The steering wheel sensor 18 can be utilized to measure a variety of characteristics of a steering wheel 20 including, but not limited to, angle, velocity, acceleration, and torque of the steering wheel 20. In other embodiments, the steering wheel sensor 18 and the steering wheel 20 may be replaced by any known input device sensor (not shown) and corresponding input device (not shown) such as a joystick or similar game device.



create a closed loop system wherein "road feel" is further improved.

The use and feel of such steering feel control processors is well known in the prior art.

5 Although the simulated steering feel system 10 may be powered by a variety of sources, in one preferred embodiment, the simulated steering feel system 10 is powered by an automotive battery 30.

Although the simulated steering feel system 10 has thus far been described in terms of an in vehicle system, the simulated steering feel system 10 can be used in a variety of other applications. Such additional applications can include, but are not limited to, laboratory testing of steering feel tuning, automotive driving simulators, or entertainment devices (such as arcade games or home entertainment units). When used in such applications, a steering feel control processor 22 can be any controlling computer device. In addition, vehicle dynamic sensors 26 can be replaced by vehicle dynamic models 32, or other informational sources containing information on "road feel" (see Figure 2). The vehicle dynamic models 32 can consist of automotive performance models or gaming simulation data, or a variety of other informational sources. In addition, in these embodiments, it is contemplated that the simulated steering feel system 10 may be supplied by any acceptable power source.

While the invention has been described in connection with one or more embodiments, it is to be understood that the specific mechanisms and techniques which have been described are merely illustrative of





### What Is Claimed Is:

1. A simulated steering feel system comprising:

a servo disk motor, said servo disk motor capable of imparting feedback torque to an input device.

2. A simulated steering feel system as described in claim 1 further comprising a steering feel control processor.

3. A simulated steering feel system as described in claim 1 further comprising at least one vehicle dynamic sensor.

4. A simulated steering feel system as described in claim 1 further comprising:

a torque multiplier, said torque multiplier utilized to magnify torque generated by said servo disk motor.

5. A simulated steering feel system as described in claim 4 wherein said torque multiplier is a gear reducer.

6. A simulated steering feel system as described in claim 1 wherein said input device is a steering wheel.

7. A simulated steering feel system as described in claim 1 further comprising a steering wheel sensor element.

8. A simulated steering feel system as described in claim 1 for use in a driving simulator.

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9. A simulated steering feel system as described in claim 1 for use in an entertainment device.

10. A simulated steering feel system as  
5 described in claim 1 for use in an automobile in conjunction with a steer by wire system.

11. A simulated steering feel system as described in claim 1 further comprising:

a motor driver element, said motor driver  
10 element utilized to operate said servo disk motor.

12. A simulated steering feel system comprising:

a servo disk motor; and

a torque multiplier, said torque multiplier  
15 used in conjunction with said servo disk motor to impart road feel to a steering wheel.

13. A simulated steering feel system as described in claim 12 wherein said torque multiplier is a gear reducer.

20 14. A simulated steering feel system as described in claim 12 further comprising:

a steering feel control processor.

15. A simulated steering feel system as described in claim 12 further comprising:

25 at least one vehicle dynamic sensor.

16. A simulated steering feel system as described in claim 12 further comprising a steering wheel sensor element.

17. A simulated steering feel system as  
30 described in claim 12 further comprising:

a motor driver element, said motor driver element utilized to operate said servo disk motor.

18. A simulated steering feel system as described in claim 12 for use in a driving simulator.

5 19. A simulated steering feel system as described in claim 12 for use in an entertainment device.

20. A simulated steering feel system as described in claim 12 for use in an automobile in  
10 conjunction with a steer by wire system.

21. A method of creating simulated steering feel comprising:

determining an appropriate feedback torque;  
and

15 transmitting said feedback torque towards the steering wheel using a servo disk motor.

22. A method of creating simulated steering feel as described in claim 21 wherein determining appropriate feedback torque comprises the steps of  
20 measuring vehicle dynamics characteristics; and

imputing an appropriate feedback torque using said vehicle dynamic characteristics.

23. A method of simulating steering feel as described in claim 21 further comprising the step of  
25 increasing the output of said servo disk motor using a gear reducer.





<b>DECLARATION AND POWER OF ATTORNEY - ORIGINAL APPLICATION</b>	<b>Attorney's Docket No. V199-1489</b>																											
<p>As a below named inventor, I hereby declare:  My residence, post office address and citizenship are as stated below next to my name;</p> <p>I verily believe I am the original, first and sole inventor or an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled</p> <p><b>SIMULATED STEERING FEEL SYSTEM</b></p> <p>the specification of which is attached hereto.</p> <p>I have reviewed and understand the contents of the specification identified above, including the claims.</p> <p>I acknowledge my duty to disclose information of which I am aware that is material to the examination of this application in accordance with Section 1.56(a), Title 37 of the Code of Federal Regulations; and</p> <p>as to application for patents or inventor's certificate on the invention filed in any country foreign to the United States of America, prior to this application by me or my legal representatives or assigns,</p> <p style="margin-left: 40px;"> <input checked="" type="checkbox"/> no such applications have been filed, or  <input type="checkbox"/> such applications have been filed as follows: </p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 20%;">COUNTRY</th> <th style="width: 20%;">APPLICATION NO.</th> <th style="width: 20%;">DATE OF FILING (day, month, year)</th> <th style="width: 20%;">DATE OF ISSUE (day, month, year)</th> <th style="width: 20%;">PRIORITY CLAIMED UNDER 35 USC 119</th> </tr> </thead> <tbody> <tr> <td style="height: 30px;"></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="height: 30px;"></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.</p> <table style="width: 100%; margin-top: 20px;"> <tr> <td style="width: 33%; border-bottom: 1px solid black;"></td> <td style="width: 33%; border-bottom: 1px solid black;"></td> <td style="width: 33%; border-bottom: 1px solid black;"></td> </tr> <tr> <td style="text-align: center;">(Application Number)</td> <td style="text-align: center;">(Filing Date)</td> <td style="text-align: center;">(Status - patented, pending, abandoned)</td> </tr> <tr> <td style="border-bottom: 1px solid black;"></td> <td style="border-bottom: 1px solid black;"></td> <td style="border-bottom: 1px solid black;"></td> </tr> <tr> <td style="text-align: center;">(Application Number)</td> <td style="text-align: center;">(Filing Date)</td> <td style="text-align: center;">(Status - patented, pending, abandoned)</td> </tr> </table> <p><b>POWER OF ATTORNEY:</b> As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith and to act on my behalf before the competent International Authorities in connection with any and all international applications filed by me. (List name and registration number)</p> <p>John A. Artz - 25,824  Mark L. Mollon - 31,123  Leslie C. Hodges - 41,843</p>		COUNTRY	APPLICATION NO.	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119														(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)				(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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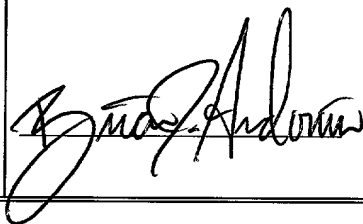
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